REMARKS

Entry of this Amendment in accordance with the provisions of 37 CFR § 1.114 is respectfully requested, noting that the present Amendment is filed as a Submission together with a Request for Continued Examination (RCE) being filed herewith.

This Amendment is in response to the Office Action dated February 5, 2004, and is further based upon a personal interview conducted between the Examiner, Michelle Crowell, her Supervisory Primary Examiner, Mr. Gregory Mills, the lead inventor in the present application, Mr. Kaji and Applicants' undersigned attorney on May 13, 2004. Appreciation is expressed for the courtesy and helpfulness of Examiners Crowell and Mills during the course of this interview.

At the interview, the rejection of the claims over the cited reference to Ohmi (USP 5,272,417) was discussed. In particular, it was noted that the proposed amendment to the claims clearly defines an unexpected result for the claim structure of a dramatic improvement in the removal of fluorine to thereby decrease the fluorine at the wafer surface, with a corresponding improvement of selectivity of etching. In considering this, together with the article provided in Appendix A (authored by Shinichi Tachi, a co-inventor of the present application, together with other co-inventors, and published after the filing of this application), Examiners Mills and Crowell indicated that if such unexpected results could be satisfactorily established, the rejections based on Ohmi, either alone or in combination with other cited prior art, in the February 5, 2004 Office Action would be removed. Accordingly, the following discussion is provided regarding this, in conjunction with the above-noted article shown in Appendix A

Independent Claim 38 and its Dependent Claims 39, 42, 43 and 46

To begin with, it is noted that independent claim 38 and its four dependent claims 39, 42, 43 and new claim 46 emphasize the following combinations of features:

1. That the apparatus is utilized for wafers having a diameter of 300 mm or more;
2. That means for decreasing the amount of fluorine in the plasma is provided, wherein the means specifically comprises:
   A. an electrode cover provided on the upper electrode containing Si or C; and
   B. the gap between the plate electrodes being in a range between 30 and 60 mm; and
3. Applying a high frequency power between 30 MHz and 200 MHz.

In particular, as discussed during the interview, the emphasis of the present claim 38 is the means plus function limitation to define the unexpected result of the dramatic increase in the removal of fluorine at the wafer surface by coordinating: (1) the structure of the upper electrode to use a Si or C cover to consume fluorine ions; and (2) the setting of the gap between the electrodes in a range of 30-60 mm, thereby significantly improving selectivity of etching by reducing the amount of fluorine at the wafer surface.

Reconsideration and allowance of the amended independent claim 38 over Ohmi is respectfully requested. As discussed during the interview, Ohmi is completely devoid of any suggestion of the particular selection of the material of the

upper electrode cover and the particular setting of the spacing to obtain the unexpected result of the significant decrease of fluorine in the plasma to decrease the amount of fluorine near the sample. Ohmi does teach silicon and carbon as possibilities for an upper electrode in a plasma etching apparatus, but also lists a number of other possibilities. For example, as discussed on column 6, line 38 et seq. of the Ohmi patent, these other possibilities include Al_2O_3, AlN, stainless steel, nickel, nickel alloy, aluminum alloy, or "other metal or alloy." Similarly, Ohmi does not recognize the particular significance of setting the gap between 30 and 60 mm defined by the present independent claim 38 for obtaining the unexpected result of the dramatic decrease of fluorine. Instead, Ohmi provides a much broader range of 20 to 100 mm (column 15, lines 63 et seq.)

With regard to the above-noted unexpected result, Appendix A provides a copy a translation of section 2.2 of an article by Shinichi Tachi, et al. (Mr. Tachi being a co-inventor of the present case) published after the filing of the present application. This article discusses the concept of "double near surface model" which is achieved by the present invention. Specifically, as noted in the article, the so called "double near side effect" is obtained by a combination of: (1) designing the upper electrode (referred to as the upper flat plate antenna in the article) to consume F radicals and (2) setting the gap between the electrodes to facilitate this consumption of fluorine by the upper electrode. As stated on page 8, line 12 et seq. of the article:

> "Further, it was considered that F radical is consumed at the flat plate antenna placed at an opposite part of the wafer to enable CF_2 radical to be selectively generated (refer Fig. 8). The F radical dissociated from CF type gas is incident to the wafer and the upper antenna surface. If a proper bias is applied to the antenna, accumulated depositions of CF type adheres to the surface react with the F radical and then F radical is consumed. This effect of

consumption has influence on the radical type incident to the wafer through the dissipation process. As the gap is made narrower, the wafer and the near surface region of the antenna overlap each other, the effect of F consumption at the antenna becomes remarkable also on the wafer surface. That is, the F incident flux for the wafer also becomes remarkable on the wafer surface. That is, the F incident flux for the wafer is restricted and a machining with a high selectivity becomes possible."

Fig. 8 illustrates this remarkable beneficial effect of the consumption of fluorine with the upper electrode ("antenna") to thereby diminish the amount of fluorine incident flux at the wafer surface, thereby significantly improving selectivity.

Fig. 9 of the article shows the role of the gap between the electrodes in achieving this desired result. Specifically, as marked in red on Fig. 9 (the red marks being added for purposes of explanation), when the gap is set below 60 mm, F can be reduced to a level that is not possible without the double near side effect (that is, without designing the upper electrodes specifically for consumption of the F radicals, as described in the article). In fact the amount of fluorine remaining using the double near side effect in the gap range of 30-60 mm is less than the absolute minimum amount of fluorine remaining without the double near side effect at any gap spacing.

Page 9, lines 9 et seq. of the article notes that 30 mm is a desirable lower limit for setting of the gap. Regarding this, page 27, line 25 et seq. of the present application explains this reason for the lower 30 mm spacing for the gap as follows:

> "The distance of the gap between the electrodes 12 and 15 is preferably not smaller than 30 mm in order to suppress a pressure difference on the sample to within 10% when the sample has a large diameter of about 300 mm or larger."

Page 28, lines 2 et seq. goes on to note the particular desirability of the 60 mm upper limit for the range as follows:

> "In order to decrease amounts of fluorine atoms, molecules and ions, the distance is desired to be not larger than 100 mm, preferably, not larger than 60 mm from the viewpoint of effectively using a reaction product on the surfaces of the upper and lower electrodes."

In the present claims, the design of the electrode to consume fluorine, as discussed in the article, is achieved by designing it to have an electrode cover containing either Si or C. These materials for the electrode cover particularly facilitate the achievement of the double near side effect described in the article. More specifically, the design of the upper electrode to consume F radicals (indicated in the article as being essential for obtaining the double near side effect) is achieved in the present invention by using the Si or C electrode cover for the upper electrode. Thus, the above-noted unexpected result of the remarkable decrease of fluorine at the wafer surface being processed is achieved using the claimed features of using Si or C for the electrode cover and setting the gap to 30 and 60 mm to thereby significantly improve selectivity.

For the reasons set forth above, it is respectfully submitted that the unexpected results of remarkably reducing the amount of fluorine at the wafer surface have been clearly disclosed in the specification and demonstrated by the article in Appendix A. Accordingly, reconsideration and allowance of independent claim 38 and its dependent claims over the cited prior art to Ohmi is respectfully requested.

As a final note regarding independent claim 38 and its dependent claims, during the interview, the specific selection of silicon from the list of materials provided by Ohmi and the setting of the gap to 30 to 60 mm from the much wider range taught by Ohmi (20 mm to 100 mm) was discussed. With regard to this,

Applicants respectfully note that the case of In re Antonie 195 USPQ 6 (CCPA 1977) is very much on point. In that case, the rejection was based on the particular selection of the claimed variables within a range of possibilities set forth in the cited El-Nagger reference. In considering this, the court stated:

> "The PTO and the minority appear to argue that it would always be obvious for one of ordinary skill in the art to try varying every parameter of a system in order to optimize the effectiveness of the system even if there is no evidence in the record that the prior art recognized that particular parameter affected the result. As we have said many times, obvious to try is not the standard of 35 USC 103 . . . and over emphasis on the routine nature of the data gathering required to arrive at appellant's discovery, after its existence became expected, overlooks the last sentence of section 103, 195 USPQ at 8."

As noted above, in the present case, the unexpected results achieved by this particular combination of Si or C for the electrode cover and the 30-60 mm gap range is completely lacking from Ohmi or any of the other cited references. As such, as in the situation of In re Antonie, "there is no evidence in the record that the prior art recognized that particular parameter affected the result." Therefore, it is respectfully submitted that the specific selection of the material for the electrode cover and the setting of the gap from Ohmi to arrive at the present claimed invention falls squarely within the "obvious to try" rationale prohibited by the case of In re Antonie.

In a similar finding from the case of In re Fine, 5 USPQ 2d 1596 (Fed. Cir. 1988), cited in MPEP 2143.01 under the heading "The Prior Art Must Suggest the Desirability of the Claimed Invention", the CAFC affirmed the rationale of the In re Antonie case in stating that:

> "The Eads and Warnick references disclose, at most, that one skilled in the art might find it obvious to try the claimed invention. But

> whether a particular combination might be "obvious to try" is not a legitimate test of patentability." 5 USPQ 2d at 1599

Similarly, in the recent case of In re Lee, 61 USPQ 2d 1430 (Fed. Cir. 2002), the CAFC stated:

> "This factual question of motivation is material to patentability, and could not be resolved on subject belief and unknown authority. It is improper, in determining whether a person of ordinary skill in the art would have been lead to this combination of references, simply to "use that which the inventor taught against its teacher." 61 USPQ 2d at 1434

In the present instance, where there is clearly no recognition of the unexpected results defined by the particular claim limitations, it is respectfully submitted that any such selective usage of the Ohmi reference to arrive at the claimed invention would be based on hindsight with benefit of the Applicants' own disclosure, and, accordingly, would be a clear example of using of "that which the inventor taught against its teacher."

For the reasons set forth above, it is respectfully submitted that the amended claim 38 and its dependent claims define both the structure and the functional features of the present invention, in proper means plus function form, and, as such, clearly define over the cited reference to Ohmi. Therefore, reconsideration and allowance of amended claim 38 and its dependent claims over Ohmi is respectfully requested.

With regard to the other cited references from the February 5, 2004 Office Action (for example, Sakamoto (USP 5,698,062) and Ishii (USP 5,529,657)), it is respectfully submitted that neither of these references teach or suggest anything to make up for the shortcomings in Ohmi noted above. More specifically, neither of

these references teach or suggest the features noted above regarding the "means for decreasing the amount of fluorine in the plasma to decrease the amount of fluorine near the sample," set forth in amended claim 38. Therefore, allowance of independent claim 38 and its dependent claims over the combination of these references with Ohmi is also respectfully requested.

New Claims 47 to 51

Reconsideration and allowance of newly submitted independent claims 47 and 50 and their dependent claims 48, 49 and 51 is also respectfully requested. Independent claims 47 and 50 define features of the invention which assist in the "double near side effect" discussed above. More specifically, each of these independent claims includes the specific recitation of the plasma density which is generated. This is disclosed, in the Specification, for example, on page 33, line 10 et seq. in order to provide desired control of the plasma to permit uniform processing. In conjunction with this, claim 47 specifically defines the setting of the gap between 30 mm and 100 mm for such uniform processing, as disclosed on page 33, line 16 et seq. Claim 50 defines this in terms of the gap between the pair of electrodes being set "to a distance capable of utilizing surface reaction between said pair of electrodes effectively." It is noted that this is a significant advantage over the prior art discussed in the background of the invention, which suffers from the problem noted on page 10, line 7 et seq. that:

> "Therefore, the construction [prior art] cannot use reaction on the surfaces of opposite electrodes effectively, and consequently it is difficult to obtain a high selectivity in this construction."

As noted on page 27, line 25 et seq., in accordance with the present invention:

> "In order to decrease amounts of fluorine atoms, molecules and ions, the distance is desired to be not larger than 100 mm, preferably not larger than 60 mm, <u>from the viewpoint of effectively using a reaction product on the surfaces of the upper and lower electrodes</u>."

It is noted that dependent claim 51 specifically define the use of the surface reaction between the pair of electrodes to decrease the amount of fluorine in the plasma near the sample, as discussed on page 27, line 25 et seq.

As such, it is respectfully submitted that the recitations of plasma density and electrode spacing set forth in independent claims 47 and 50, and their respective dependent claims, serve to clearly distinguish over the cited primary reference to Ohmi, as well as the other cited prior art in this case. Therefore, reconsideration and allowance of claims 47-51 is also respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of

this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Docket No. 520.35237VX3), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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APPENDIX A

" 2-2. Double near surface model"

Then, an oxidation film etching will be described as follows. In the case of the oxidation film etching process, parallel flat plate type plasma (CCP, M-RIE) is used in many semiconductor mass-production lines. On the other hand, the high density plasma has a low selectivity and this is not frequently used. In the case of oxidation film etching, CF type gas ($C4F_8$, $C5F_8$, $C4F_6$ etc.) is used in order to assure a resist and a base selectivity. CF type gas is dissociated into CF_2, C, F etc. in plasma and excessive dissociation causes either C or F to be generated. Excessive C radical becomes a cause of stopping etching operation and F radical reduces a selectivity of a resist mask or a base. Accordingly, excessive dissociation at the high density plasma source causes a high selectivity or long-term stability to be hardly attained.

On the contrary, the parallel flat plate type plasma source has a short gap of about 10 to 20 mm and a low density as compared with that of the high density plasma. Accordingly, CF type gas such as C_4F_8 etc. is dissociated properly and much amount of CF_2 is generated, so that a high selectivity can be attained. However, only CF_2 is excessively generated due to an excessive narrow gap, so it has been made difficult to attain a vertical machining shape. Further, it is considered that a gas pressure

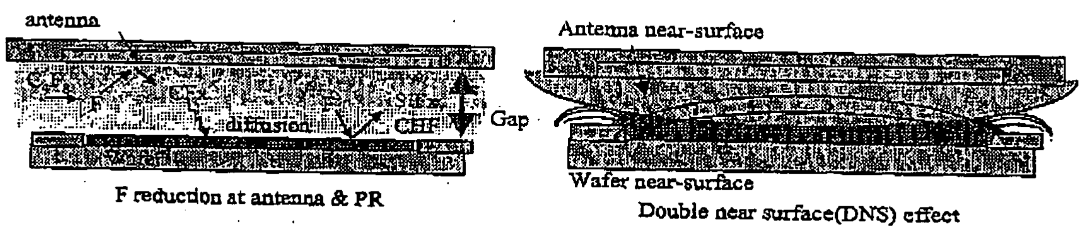
distribution becomes high within a wafer plane under a high flow rate condition of gas or a condition of low gas pressure (3 Pa or less) and a uniform etching is hardly carried out.

In view of the foregoing, it was judged to have a necessity that a rate of CF_2 with respect to F (CF_2/F) is controlled high and a ratio of CF_2 in respect to ion (CF_2/ion) is kept low for attaining both selectivity and vertical machining characteristic. As to the ratio of CF_2/F, a middle density plasma is used and the gap is adjusted to enable a certain high CF_2/F ratio to be attained through restriction of the excessive dissociation. Further, it was considered that F radical is consumed at the flat plate antenna placed at an opposite part of the wafer to enable CF_2 radical to be selectively generated (Refer Fig.8).

The F radical dissociated from CF type gas is incident to the wafer and the upper antenna surface. If a proper bias is applied to the antenna, accumulated depositions of CF type adhered to the surface react with the F radical and then F radical is consumed. This effect of consumption has influence on the radical type incident to the wafer through the dissipation process. As the gap is made narrower, the wafer and the near surface region of the antenna overlap to each other, the effect of F consumption at the antenna becomes remarkable also on the wafer surface. That is, the

F incident flux for the wafer also becomes remarkable on the wafer surface. That is, the F incident flux for the wafer is restricted and a machining with a high selectivity becomes possible.

Fig.8 Double near surface phenomenon



In Fig.9 is indicated a result in which the gap dependency of the incident flux is calculated by the double near surface model. The incident flux of F radical can be controlled between the gaps ranging from 30 to 120 mm. Further, it is apparent that F radical is reduced due to the double near surface effect and F radical is scarcely generated at the gap 30 mm.

Fig.9 Controlling flux of F